NORTON SOUND WINTER RED KING CRAB STUDIES

1989

By

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Introduction

The 1989 nearshore Winter King Crab Investigations Project was expanded over previous studies. The project was initiated in February of 1982 with sampling procedures standardized in 1983. Results of prior studies were reported by Schwarz and Lean 1982, 1983, 1984, and Lean 1987. Renewed interest in offshore gold dredging in the vicinity of popular subsistence crabbing areas along with the incorporation of additional crab research projects has increased the scope of the winter study.

In past years the study area was restricted to a narrow section of ice, oriented straight offshore from the Nome State office building and extending 1/2 to 2 miles out. The area was expanded in 1989 to 6 miles west of Nome in the vicinity of recent dredging and 6 miles east of Nome where there is very little subsistence crabbing effort. Shorefast and sea ice conditions are constantly changing and vary from one location to another. The entire 1988 season had been missed due too unstable ice beyond the 25 foot isobath. With the increased study area, not only are mining and subsistence issues addressed, the chance of a missed season as a result of poor ice conditions is reduced.

Objectives

The primary objective of the project since 1982 had been to monitor nearshore abundance and distribution of king crab during the months of highest local use. Secondary objectives included: testing of new tag types, tagging for growth and frequency of molting estimates, establishing a size distribution for estimating recruitment, monitoring rates of recapture in study pots, monitoring crab migration and determining the time of mating through examining female crab shell age and egg development.

Objectives added to this list in 1989 included: cold air exposure tolerance tests, sample collection for electrophoretic analysis, mechanical shell age determination and artificial crab bait testing. Monitoring of abundance and distribution of crab along with dredging impacts increased as the study area expanded.

Methods

Study Area

During the 1983 study four permanent fishing stations were established at various depths so that the distribution of crab in nearshore waters could be evaluated (Figure 1). Station one was approximately one-half mile from shore and in water measuring 20 feet in depth from the working surface of the ice to the ocean floor. Stations two, three and four were approximately 0.75, 1.25 and 2 miles

offshore in depths of 42, 50 and 60 feet respectively. Depths were checked using a weighted string before establishing a station. Proper location along the shore was determined by aligning the middle White Alice tower with the stack on top of the post office. Since 1983 attempts have been made to locate tests spots as closely to these sites as possible so that results would be comparable.

In 1989 only stations 2 and 3 were utilized due to the changed project design and they were renamed Nome 2 and Nome 3 respectively. In addition three new test sites were established. One station was located approximately 6 miles East of Nome in alignment with the V.O.R. transmitter and the White Alice tower out to a depth of 39 feet. The site was labeled East 1. Two other stations were placed approximately 6 miles West of Nome, labeled West 1 and 2 with water depths of 40 and 50 feet respectively. The location of station West 1 was at the intersection of three rays. One ray was line of sight along the major mountain ridge between Bowhead and Willow Creeks. Another was along the Anvil Mountain west ridge. And the third ray was the alignment of a rock outcropping, near the Teller Road between Penny River and Sunset Creek, with the 1270 foot peak directly North. Station West 2 was located due south of West 1 along the third alignment.

Test Fishing

Throughout the history of the project the same crab pot design has been used. The pots were purchased at "Arc 'n' Spark" Welding, Inc." in Kodiak, Alaska. The shape of the pot is a truncated cone with a base diameter of 4 feet and top diameter of 24 inches with a height of roughly 24 inches. The entrance is 16-18 inches in diameter located in the center of the top and there is a 6-8 inch plastic collar hanging from the entrance to keep crab from escaping.

Standardized baiting of pots was conducted so that differing catches between stations would not be attributed to the amount of bait used but rather to differences in the abundance of crab at each station. Two, one quart bait containers of chopped herring and a string of 10 saffron cod were put in each pot, each time they were sampled. Bait was thawed before use, although it occasionally became partially refrozen before it could be put into the pot. The herring used was commercial quality bait purchased from a floating processor during the summer commercial crab fishery. Some of the saffron cod were caught in the early fall and stored frozen until used.

A slip knot was tied in the line while lowering the pot so that when the pot was set the knot was about 6 feet below the surface. In this way it could be determined if the pot had been checked by unauthorized people. The slip knot had a second function which was to provide some slack in the line so that the pot would not be lifted off the bottom if the ice heaved. If the knot was found untied but the surface of the hole was frozen smooth, then the ice had probably heaved. Robbed pots were noted and excluded from the CPUE calculations.

The following is a summary of the sampling procedure; detailed instructions on how the catch was processed are given in the operational plan. Pots were brought near the surface and suspended so that all the crab in the pot were covered with about a foot of water. Crab were removed individually, placed in

a heated shed, measured, shell age was determined, egg development was noted on females and most legal sized male crab were tagged with hog ring tags and elastrator bands. Crab were then released through the same hole that the pot was suspended in. On the average, crab spent less than 10 seconds exposed to the outside air temperature which ranged from 30°F to -25°F. When the eggs were not clearly in the eyed condition, samples were taken in order to assess egg development. Dissections were made of females without or with only partial egg clutches, so that ovary development could be noted.

Catch per unit effort (CPUE) was calculated in the form of catch per pot lift. CPUE was not standardized by accounting for differences in fishing time because the effectiveness of bait is thought to drop off rapidly with time. The rapid deterioration of the bait can be further accelerated due to consumption by captured crab or sand fleas. An attempt to standardize fishing methods and minimize the effect of fishing time has been made since 1983. Bait has been standardized so that variations between pots has been minimized and the crew made an effort to check the pots twice each week on non-adjacent days. Due to the difficulty of standardizing CPUE, catch per pot lift was considered a sufficiently good index of crab abundance for an abundance indexing program.

Cold Temperature Tolerance

The objective of this study was to determine if repeat exposure of crab during simulated commercial fishing practices causes mortality within a short time period. Project procedures are outlined in greater detail in Appendix 2 of the 1989 Operational Plan for the Nome Area Winter King Crab Study.

Three additional pots were required for this study, one at each of three stations; Nome 2, West 1, and West 2. Therefore, there were 2 pots at each location, one fished regularly for the winter crab study and the other with the escape opening wired shut to retain crabs for this study. The sample size for each pot was 20 crab: 5 control crab that were exposed only during the initial tagging procedure which took approximately 3 minutes; 5 crab that were exposed for 5 minutes; 5 crab that were exposed for 10 minutes; and 5 crab that were exposed for 15 minutes.

During the first week all crab were tagged and randomly assigned to a treatment exposure level of 3, 5, 10, or 15 minutes of cold air then exposed the corresponding amount of time. The second week, crab in the Nome I pot were only fed, while crab in the other two pots were fed and exposed again for the corresponding time period. The third week, crab in the Nome 1 and West I pots were only fed while crab in the West 2 pot were fed and exposed a third and final time for the corresponding time period. During these periods and the following weeks, each of the study pots were checked for mortalities and fed when the regularly fished pots were checked. Air temperature and wind speed were recorded each time the crab were exposed.

Collection of Electrophoretic Samples

Electrophoretic analysis techniques can be utilized to distinguish separately breeding crab stocks. The purpose of sample collection here was to add the Norton Sound red king crab to the Alaska stock catalog.

Red king crab specimens were collected from the regularly fished pots and transported back to the office lab in Nome. Sex and carapace length were noted. Heart, leg muscle, gill and hepatopancreas tissues were dissected out of each crab and placed in separate polystyrene test tubes which were immediately frozen after labeling. Samples were later placed in packing boxes with dry ice and shipped to Drs. Jim and Lisa Seeb at Southern Illinois University to be examined. Data analysis will follow in their report. Detailed collection procedures are found in Appendix 1 of the 1989 Winter King Crab Operational Plan.

Results

Test Fishing

A total of 548 male and 9 female red king crab were captured in 42 pot lifts from February 10 through April 19 (Table 1). The average pot lift caught 13.0 male and 0.2 female crab. The mean male catch per pot lift by station was 22.3, 8.8, 17.8, 14.6 and 5.1 for stations E1, N2, N3, W1, and W2 respectively (Table 2). Appendix Tables 1-5 present each station's daily catch. Two hundred hog ring tags were attached to healthy new shell male crab over 89 mm carapace length.

Catch Sampling

A total of 512 male king crab were measured for carapace length and categorized by shell condition with 42% being sublegals and 58% legals (Table 3). Of the 296 legal male crab captured 47% were recruits and 53% were postrecruits. The average carapace length was 105 mm. Females comprised 2% of the total test catch. Fourteen female crab, including 5 which were captured in a subsistence pot, were measured and categorized as to the percent fullness of egg clutch and egg stage (Table 4). Equal numbers of eyed eggs and purple eggs were observed while 65% of the specimens had a 90-100% clutch size. Fourteen percent of the females examined were juveniles with no eggs. The mean carapace length of females was 79 mm.

Cold Temperature Tolerance

Fifty percent of the original 60 crab that began the study on March 3 were still alive at the end of 6 weeks. Table 5 shows that mortality definitely increases with increased exposure to cold air temperatures. Crab did not die immediately but rather got sickly with swollen abdomens and sluggish movement. It is possible that crab in the sick condition may have actually died from other causes such as sand fleas which were found in great numbers in skeletal remains and occasionally devouring almost entire carapaces within one week. It is interesting to note that crab which were exposed a single time may take 6 weeks

to die. Also crab which were exposed for only a brief amount of time similar to normal fishing conditions in the area usually survived.

Additional Investigations

Shell Age Determination

Shell age determination is usually a subjective observation, but is important when distinguishing recruit from post recruit crab. A durometer was tested to see if shell age could be determined mechanically. The durometer used was a model CRB-IV. It registers a relative hardness of an object by simply pressing the point of the durometer on the object and reading the guage. Unfortunately the durometer could not distinguish shell ages of 6 months from those of 18 months. It was also found that readings varied as much as 5 points with a 30° F temperature change.

Artificial Crab Bait

A small battery powered diode flashing light contained in a sealed clear cylinder was tested to see if it would attract crab. Two of these lights were hung in a crab pot which was baited and fished as usual. Upon checking the pot 8 crab were caught where the typical catch would have been only starfish. Therefore the lights did seem to increase the catch, however more testing should be done before definite conclusions are drawn.

Habitat Monitoring and Mining.

In past years aerial surveys of fishing effort have been flown to document the distribution of subsistence fishermen. The operational plan had included a similar mapping exercise for this season's project. It was intended to monitor the effect of benthic mining impact on catch rates of subsistence fishermen. Unfortunately record snow falls adversely effected fishing distribution and effort to the extent that mapping exercises were dropped.

Discussion

The 1989 winter crab study resulted in a catch rate below the average of the previous 5 seasons fished (Table 6). The sublegal catch decreased, post recruits increased, while recruits remained fairly consistent (Table 7). If test fishing can be used as an indicator of the population structure, the 1990 season would probably have a lower percentage of recruit than post recruits again. In 1987 prerecruit twos were weak and were followed by weak prerecruit ones in 1989. Therefore it might follow that recruits in 1990 may be low. The prerecruit two catch was fairly high in 1989 and may indicate that the population is beginning to rebuild. The shift in strength from recruits to post recruits can also be observed in the summer commercial fishery (Table 8). Since both the winter test

fish and the summer commercial catches indicate a similar trend, the winter crab studies may become a more important management tool.

Future Investigations

It is apparent by looking at Figure 2 that the winter pot study samples a separate segment of the crab population from the summer commercial fishery. Winter catches include smaller size crab but also indicate similar trends of the legal size component as found in the summer commercial catch. Therefore an effort should be made to sample still smaller crab as it may reflect a wider range of the population age structure which may eventually predict recruitment of adult crab into the fishery based on relative abundances.

Another reason for studying juvenile crab is to get a better idea of how mining impacts the earlier life stages. It is accepted that large crab are fairly mobile. They can move away from dredging activity and can forage greater distances than small crab. In light of the proposed additional offshore mining lease sales it is important to know more about the early life history of crab now to help monitor the impact of dredging in the future.

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Table 1. Winter king crab daily catch totals for all stations combined, Norton Sound Section, 1989. 1/

Date of pot lift	Number of pots lifted	Number of males captured	Number of females captured	Avg. male catch per pot lift
2/10	1	1	0	1.0
2/14	1	6	0	6.0
2/18	1	2	1	2.0
2/21	2	31	0	15.5
2/27	2	37	0	18.5
3/03	1	24	0	24.0
3/04	1	25	1	25.0
3/11	3	86	0	28.7
3/14	3	60	0	20.0
3/17	4	60	1	15.0
3/22	1	22	0	22.0
3/23	3	48	1	16.0
3/24	1	7	0	7.0
3/29	1	33	0	33.0
3/30	2	5	1	0.5
3/31	2	8	0	4.0
4/05	3	61	3	20.3
4/10	4	30	0	7.5
4/11	1	0	0	0.0
4/17	2	0	1	0.0
4/18	1	1	0	1.0
4/19	2	1	0	0.5
Totals	42	548	9	13.1

1/ Stations combined include: E1, N2, N3, W1 and W2.

Table 2. Comparison of Norton Sound winter king crab catches by station, 1989.

Station	Number of pots lifted	Number of males captured	Avg. male catch per pot lift	Number of females captured	Avg. female catch per pot lift
E1	7	156	22.29	3	0.43
N2	13	114	8.77	2	0.15
N3	6	111	17.83	4	0.67
W1	9	131	14.60	0	0.00
W2	7	36	5.14	0	0.00
Totals	42	548	13.05	9	0.21

Table 3. Male king crab size frequency distribution obtained from all stations, winter crab study, Norton Sound Section, 1989.

Carapace length(mm)	Number Measured new	old	v.old	
prerecruit two or smaller				total
61-62	1	0	0	1
63-64	0	0	0	0
65-66	1	0	0	1
67-68	1	0	0	1
69-70	0	0	0	0
71-72	3	0	0	3
73-74	6	0	0	6
75-76	10	0	0	10
77-78	12	0	0	12
79-80	10	0	0	10
81-82	21	0	0	21
83-84	20	0	0	20
85-86	19	0	0	19
87-88	22	0	0	22
Total	137	0	0	137
prerecruit one				
90	5	0	0	5
91-92	11	0	0	11
93-94	15	0	0	15
95-96	10	0	0	10
97-98	11	0	0	11
99-100	9	1	0	10
101-102	10	0	0	10
103-104	5	0	0	5
105-106	1	0	0	1
107-108	0	0	0	0
109-110	0	0	0	0
111-112	1	0	0	1
Total	78	1	0	79
Sublegal total	215	1	0	216

Carapace length(mm)	Number Measured new	old	v.old	
Legal males				total
100-101	2	0	1	3
102-103	10	1	0	11
104-105	20	4	0	24
106-107	21	2	1	24
108-109	17	5	1	23
110-111	25	6	1	32
112-113	13	5	1	19
114-115	20	6	0	26
116	12	5	1	18
Total	140	34	6	180

*old shell male crab between 100-115 mm are post recruits

Legal males (post recruits)				
117-118	22	7	3	32
119-120	18	3	5	26
121-122	9	4	3	16
123-124	10	3	3	16
125-126	5	4	1	10
127-128	2	2	1	5
129-130	2	0	3	5
131-132	3	1	1	5
133-134	0	0	0	0
135-136	0	1	0	1
137-138	0	0	0	0
Total	71	25	20	116
Legal total	211	59	26	296
Grand total	426	60	26	512

Table 4. Winter king crab egg development observations, Norton Sound Section, 1989. 1/

Date of Capture	Pot #	Carapace Length (mm)	Shell Age (months)	Clutch Size (%)	Comments
2/18	N2	78	11-12	90-100	eyed eggs
3/04	N2	77	11-12	90-100	eyed eggs
3/17	N3	86	1-2	90-100	purple eggs
3/23	N3	75	1-2	90-100	purple eggs
3/30	N3	72	1-2	60-80	purple eggs
4/04	E1	74	1-2	90-100	purple eggs
4/04	E1	95	11-12	90-100	eyed eggs
4/04	E1	68	1-2	Juvenile	no eggs
4/16	WSub	79	1-2	30-59	purple eggs
4/16	WSub	84	11-12	90-100	eyed eggs
4/16	WSub	94	11-12	90-100	eyed eggs
4/17	N3	84	11-12	90-100	eyed eggs
4/24	WSub	74	1-2	60-89	purple eggs
4/24	WSub	65	11-12	Juvenile	no eggs

1/ Includes data obtained from a designated substence pot (Wsub).

Table 5. Exposure of king crab to cold temperature, Norton Sound Section, 1989.

Pot 1/	Exposure Group(min)	3/11	3/15	3/24	3/30	4/5	4/11	4/17
			Cumulative Mortality by Date					
N2	3	start	0	0	0	0	0	0
	5		0	0	0	0	0	1
	10		0	0	0	0	0	1
	15		0	1	1	2	2	2
	Air Temp (F)	25	4	25	18	21	29	
	Wind Speed (mph)	16	0	8	3	10	17	

		3/11	3/15	3/23	3/31		4/10	4/19
			Cumulative Mortality by Date					
W1	3	start	0	0	0		0	0
	5		0	0	0		1	2
	10		0	0	2		4	4
	15		0	3	3		5	5
	Air Temp (F)	25	11	16	15		24	
	Wind Speed (mph)	15	0	5	5		5	

		3/11	3/15	3/23	3/31		4/10	4/19
			Cumulative Mortality by Date					
W2	3	start	0	0	0		2	2
	5		0	0	1		3	3
	10		0	2	3		5	5
	15		0	3	5		5	5
	Air Temp (F)	25	4	16	15		20	
	Wind Speed (mph)	15	0	5	5		5	

1/ N2 exposed one time.
W1 exposed two times.
W2 exposed three times.

Table 6. Comparison of Norton Sound winter king crab catches by year, 1989.

Station	Number of pots lifted	Number of males captured	Avg. male catch per pot lift	Number of females captured	Avg. female catch per pot lift
1982 1/	60	246	4.1	10	0.2
1983	107	2586	24.0	236	2.0
1984	70	1677	24.0	78	1.1
1985	31	760	24.5	14	0.5
1986	31	594	19.2	74	2.4
1987	26	151	5.8	6	0.2
1988 2/					
1989 3/	19	221	11.6	6	0.3
1989 4/	42	548	13.1	9	0.2

1/ Fishing stations and baiting techniques were not standardized.
2/ No data due to unstable ice conditions.
3/ Data from stations N2 and N3 only.
4/ Combined data from stations E1, N2, N3, W1, and W2.

Table 7. Comparison by year of Norton Sound Section king crab from winter research pots, percent by size catagories, 1989. 1/

	Sublegal			Legal		
		Pre-recruit			Post	
Year	Twos	Ones	Totals	Recruits	recruits	Totals
1983	26	38	64	26	10	36
1984	35	31	66	19	16	35
1985	25	45	70	20	10	30
1986	26	35	61	22	17	39
1987	13	31	44	11	45	56
1988 2/						
1989	27	15	42	27	31	58

1/ Sublegals = male king crab less than 4 3/4" carapace width.
Pre-recruit Ones = Sublegals greater than 89mm in carapace length.
Pre-recruit Twos = Sublegals smaller than 90mm in carapace length.

Legal = male king crab greater than 4 3/4" carapace width.
Recruits = Legal new shell crab smaller than 116mm in carapace length.
Post-recruits = all non-recruit legal males.

2/ No data collected in 1988 due to poor ice conditions.

Table 8. Comparison of percent recruit and post-recruit king crab sampled from the summer commercial fishery and winter research, Norton Sound Section, 1983-1989.

Year	Winter Research		Summer Commercial	
	Recruits	Post-recruits	Recruits	Post-recruits
1983	73	27	55	45
1984	54	46	59	41
1985	68	32	45	55
1986	55	45	48	52
1987	20	80	22	78
1988 1/			25	75
1989	47	53	23	77

1/ No data collected in winter 1988 due to poor ice conditions

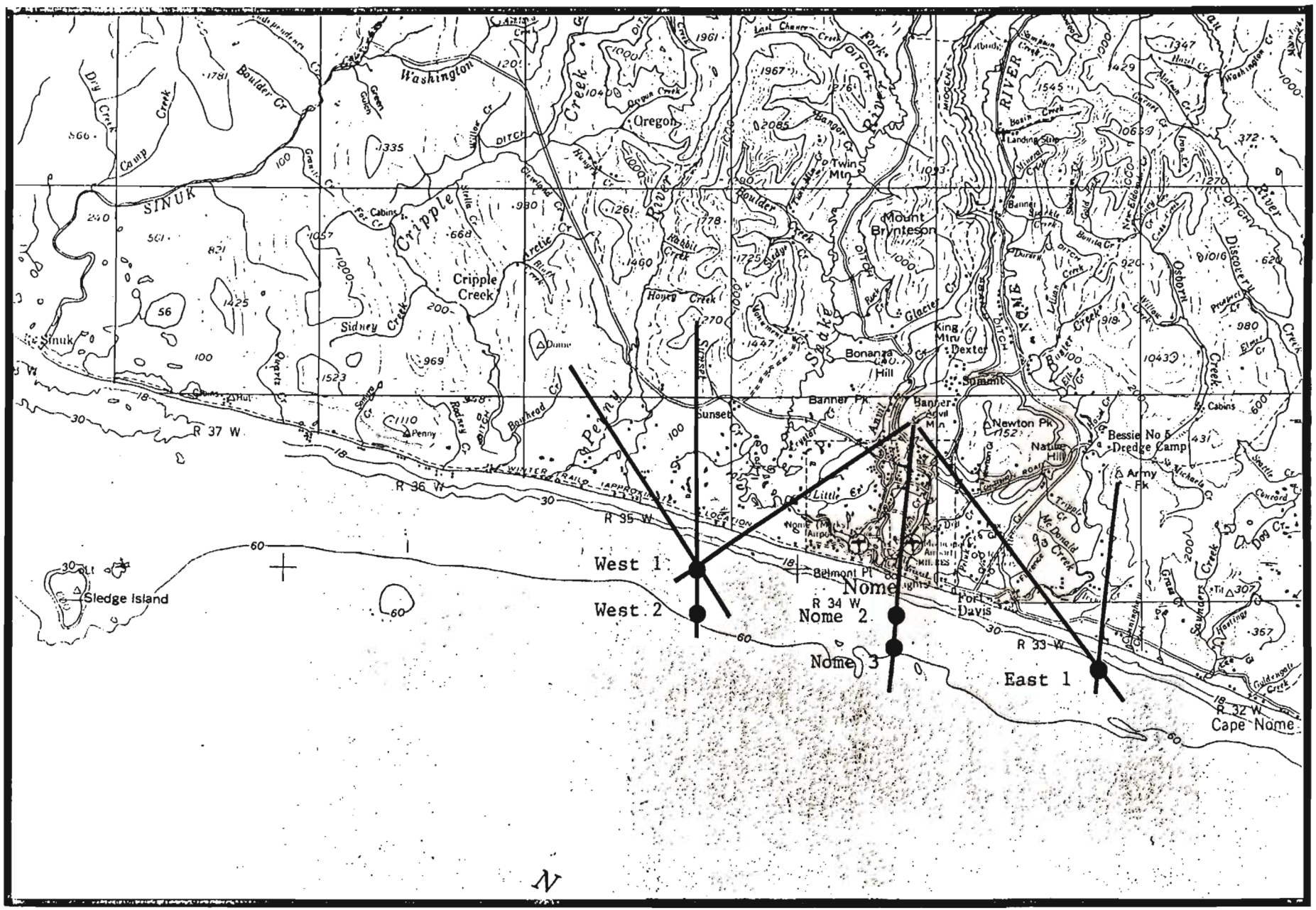

Figure 1. Winter king crab study area and pot locations, Norton Sound Section, 1989.

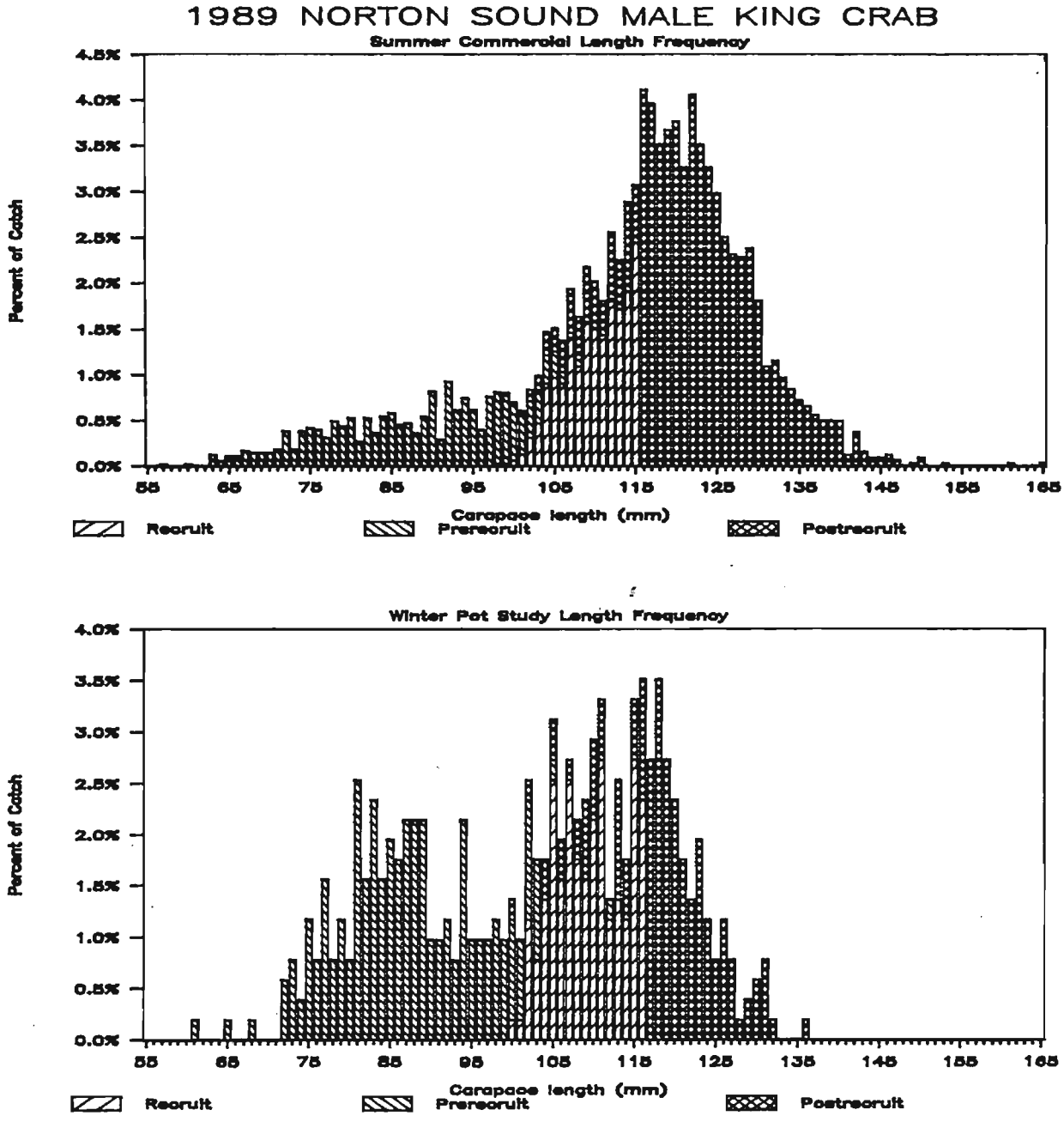

Figure 2. Comparitive length frequency distributions of recruit, prerecruit, and postrecruit male king crab, Norton Sound Section, Eastern Bering Sea, 1989.

APPENDICES

Appendix
Table 1. Winter king crab test pot catch data, station E1, Norton Sound Section, 1989.

Date of pot lift	Soak time (days)	Number of males captured	Cum. males captured	Number of females captured	Cum. females captured
2/27	5	13	13	0	0
3/14	6	40	53	0	0
3/22	8	22	75	0	0
3/29	7	33	108	0	0
4/05	7	36	144	3	3
4/10	5	11	155	0	3
4/18	8	1	156	0	3
7 Lifts	46				

Avg. number of males per pot lift: 22.3
Avg. number of females per pot lift: 0.4

Appendix
Table 2. Winter king crab test pot catch data, station N2, Norton Sound Section, 1989.

Date of pot lift	Soak time (days)	Number of males captured	Cum. males captured	Number of females captured	Cum. females captured
2/10	2	1	1	0	0
2/14	4	6	7	0	0
2/18	4	2	9	1	1
2/21	3	16	25	0	1
2/27	6	24	49	0	1
3/04	5	25	74	1	2
3/11	7	25	99	0	2
3/17	6	5	104	0	2
3/24	7	7	111	0	2
3/30	6	0	111	o	2
4/05	6	3	114	o	2
4/11	6	0	114	0	2
4/17	6	0	114	0	2
13 Lifts	68				

Avg. number of males per pot lift: 8.8
Avg. number of females per pot lift: 0.2

Appendix
Table 3. Winter king crab test pot catch data, station N3, Norton Sound Section, 1989.

Date of pot lift	Soak time (days)	Number of males captured	Cum. males captured	Number of females captured	Cum. females captured
3/17	3	35	35	1	1
3/23	6	35	70	1	2
3/30	7	5	75	1	3
4/05	6	22	97	0	3
4/10	5	14	111	0	3
4/17	6	0	111	1	4
6 Lifts	33				

Avg. number of males per pot lift: 18.5
Avg. number of females per pot lift: 0.7

Appendix
Table 4. Winter king crab test pot catch data, station W1, Norton Sound Section, 1989.

Date of pot lift	Soak time (days)	Number of males captured	Cum. males captured	Number of females captured	Cum. females captured
2/21	4	15	15	0	0
3/03	12	24	39	0	0
3/11 1/	8	35	74	0	0
3/14	3	14	88	0	0
3/17	3	16	104	0	0
3/23	6	13	117	0	0
3/31	8	8	125	0	0
4/10	10	5	130	0	0
4/19	9	1	131	0	0
9 Lifts	63				

Avg. number of males per pot lift: 14.6
Avg. number of females per pot lift: 0.0

1/ Pot location moved from 20 to 30 foot water depth.

Appendix
Table 5. Winter king crab test pot catch data, station W2, Norton Sound Section, 1989.

Date of pot lift	Soak time (days)	Number of males captured	Cum. males captured	Number of females captured	Cum. females captured
3/11	8	26	26	0	0
3/14	3	6	32	0	0
3/17	3	4	36	0	0
3/23	6	0	36	0	0
3/31	8	0	36	0	0
4/10	10	0	36	0	0
4/19	9	0	36	0	0
7 Lifts	47				

Avg. number of males per pot lift: 5.1
Avg. number of females per pot lift: 0.0